NATIONAL PH.D. PROGRAM IN AUTONOMOUS SYSTEMS

Supervised Autonomy, learning effectively from human supervision

Ph.D. candidate

Alessandro Adami

Cycle

XL

Tutors

Prof. Pietro Falco (primary one)
Prof. Luca Schenato
Prof. Ruggero Carli
Mr. Aris Synodinos (ABB, company tutor)

1. Description of the research program

The research program continues the development of themes explored during the master's thesis period, which are closely related to Supervised Autonomy. In this initial phase, we aim to advance the state of the art in autonomously learning a prioritized order of tasks with relative parameters, through Reinforcement Learning and Genetic Programming techniques. This will be supported by real experimental results conducted in the company's laboratory during the first year.
Subsequently, the research will focus on an extensive literature review of Large Language Models for high-level human-robot interaction, laying a foundation with the introduction of Preference-Based Reinforcement Learning. This approach will enable the algorithm to maximize rewards following human-like behaviors. The literature review will aim to acquire deep knowledge of the research topics and identify unexplored research areas and potential future developments.
During the first year at the University of Padova, these topics will be significantly expanded to build a theoretical framework, which will serve as base for developing an initial algorithm.

In the second year, research will continue first at the company's research center in Västerås, followed by the KTH Royal Institute of Technology in Stockholm. During this period, the algorithm, based on the previously developed framework, will be developed and tested on a real robot.
The 6-month abroad and company periods will be carried out during this time.

Currently, no research plans are scheduled for the third year.

2. Schedule of the research activities

First academic year (planned)

	Description	Period	Activity abroad
Master thesis refinement for company requirements	Development of an algorithm tailored to the company's needs for the learning of a set of tasks, following results obtained during the development of master thesis degree.	November 2024	NO
Master thesis test on a real robot	Abroad period at the company to test the previously developed algorithm on a real robot in their laboratory environment.	December 2024	YES
Literature review	In this phase, an extensive literature review will be conducted for topics related to the research program, identifying the areas of potential development in the state of art.	December 2024 . September 2025	NO
Theoretical framework development	Based on the previous literature review, a framework will be developed. It will be the base for future implementation of algorithms.	December 2024 . September 2025	NO

Second academic year (planned)

	Description	Period	Activity abroad
Company period of 6 months	Six months period at the company	October 2025-March 2026	YES
Abroad period of 6 months	Six months period abroad at Royal Institute of Technology (KTH), SWEDEN	April 2026-September 2026	YES

Third academic year (planned)

	Description	Period	Activity abroad
Insert name of first research activity			NO
Insert name of second research activity			NO

3. Training and research activities plan

First academic year (planned)

	Description	Period	Final Exam	ECTS
A. Ph.D. courses	**Entrepreneurship and Startup (Padova)**	TBD	Yes	2 (21h)
	Python programming for Scientific Engineering (Padova)	TBD	Yes	2 (20h)
	Applied Functional Analysis and Machine Learning :from regularization to deep networks (Padova)	TBD	Yes	2 (24h)
	Deep Reinforcement Learning for control of Autonomous Systems	TBD	Yes	1
	Game theory for controlling Autonomous Systems	May ‘25	Yes	1
	Gaussian Processes for modeling and control of robotics systems	Jan. ‘25-Feb. ‘25	Yes	2
	Human Autonomous Systems interaction	Feb. ‘25-Mar. ‘25	Yes	1
	Intelligent supervisory systems	Jan. ‘25	Yes	2
	Introduction to Autonomous systems	June ‘25	Yes	1
	Linear and non linear Kalman filtering	Feb. ‘25	Yes	2
	Bayesian Machine Learning (Padova)	TBD	Yes	2 (20h)
	Elements of deep learning	TBD	Yes	2 (24h)
B. Master’s degree courses				
C. **Soft skill courses**				
D. Participation to seminars	**Distributed Machine Learning and Optimization: from ADMM to Federated and multiagent Reinforcement Learning (Padova)**	TBD	No	2
	Fundamentals of Adaptive Control for Applications (Padova)	TBD	No	2
E. Participation to international congresses or workshops				
F. Presentation of research products at international congresses or				

workshops				
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			24
G. Individual research activity	Literature review and framework development			36
H. Supervision of students				
I. Integrative teaching activities				
J. Preparation of manuscripts for conferences or journals				
	TOTAL OF ECTS FOR RESEARCH ACTIVITIES			36
	TOTAL OF ECTS			**60**

Second academic year (planned)

	Description	**Period**	**Final Exam**	**ECTS**
A. Ph.D. courses			Yes/No	
			Yes/No	
			Yes/No	
B. Master's degree courses			Yes/No	
			Yes/No	
C. Soft skill courses			Yes/No	
D. Participation to seminars				
E. Participation to international congresses or workshops				
F. Presentation of research products at international congresses or workshops				
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			
G. Individual research activity				
H. Supervision of students				
I. Integrative teaching activities				
J. Preparation of manuscripts for conferences or journals				
	TOTAL OF ECTS FOR RESEARCH ACTIVITIES			
	TOTAL OF ECTS			**60**

Third academic year (planned)

	Description	**Period**	**Final Exam**	**ECTS**
A. Ph.D. courses			Yes/No	
			Yes/No	

			Yes/No	
B. Master's degree courses			Yes/No	
			Yes/No	
C. Soft skill courses			Yes/No	
D. Participation to seminars				
E. Participation to international congresses or workshops				
F. Presentation of research products at international congresses or workshops				
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			
G. Individual research activity				
H. Supervision of students				
I. Integrative teaching activities				
J. Preparation of manuscripts for conferences or journals				
	TOTAL OF ECTS FOR RESEARCH ACTIVITIES			
	TOTAL OF ECTS			**60**

4. List of the publications written by the candidate in the triennium

International Journal Articles

International Conference Proceedings

Alessandro Adami

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Prof. Pietro Falco

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Prof. Luca Schenato

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Prof. Ruggero Carli

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Mr. Aris Synodinos

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